The Banana Pi BPI-PicoW-S3 is a series of low-powered microcontrollers designed for IoT development and Maker DIY board.same size as Raspberry Pi Pico board,It supports 2.4 GHz Wi-Fi and Bluetooth® LE dual-mode wireless communication, the peripheral is compatible with low-power hardware design, and the power consumption is only 10uA in deep sleep mode.In terms of programming, the PicoW-S3 supports ESP-IDF, Arduino, micropython and other methods.

key features

- ESP32-S3, Xtensa® 32 bit LX7
- External PSRAM, FLASH
- Ultra-low power 10uA
- 2.4G WIFI, Bluetooth 5, Bluetooth mesh
- GPIO, ADC, TOUCH, PWM, I2C, SPI, RMT, I2S, UART, LCD, CAMERA, USB, JTAG
- 1*microUSB
- 1*Full color LED

BPI-PicoW-S3 VS Raspberry Pi PicoW, BPI-Leaf-S3, ESP32-S3-DevKitC-1

Development board	BPI-PicoW-S3	Raspberry Pi PicoW	BPI-Leaf-S3	ESP32-S3-DevKitC-1
GPIO pinout	27	27	36	36
3.3v pin	1	1	2	2
5v pin	2	2	1	1
GND pin	8	8	4	4
Full color LED	1 on GPIO48	None	1 on GPIO48	1 on GPIO48
Chip directly connected to USB	MicroUSB port x1	MicroUSB port x1	Type-C USB port x1	MicroUSB port x1
UART TTL to USB	None	None	None	CP2102-MicroUSB interface x1
External battery socket	None	None	3.7v lithium battery power supply interface	None
Battery charging	None	None	500mA charging	None
I²C 4pin connector	None	None	1	None

Espressif ESP32-S3

Esp32-S3 is an MCU chip that integrates 2.4 GHz Wi-Fi and Bluetooth 5 (LE) and supports Long Range mode. The ESP32-S3 runs on an Xtensa® 32-bit LX7 dual-core processor with a high frequency of 240 MHz, 512 KB built-in SRAM (TCM), 45 programmable GPIO pins, and a rich communication interface. Esp32-s3 supports larger capacity of high-speed Octal SPI flash and off-chip RAM, and supports user-configured data caching and instruction caching.

What follows is a description of the most important features of ESP32-S3.

- Wi-Fi + Bluetooth 5 (LE) Wireless Connectivity: ESP32-S3 supports a 2.4 GHz Wi-Fi (802.11 b/g/n) with 40 MHz of bandwidth support. The Bluetooth Low Energy subsystem supports long range through Coded PHY and advertisement extension. It also supports higher transmission speed and data throughput, with 2 Mbps PHY. Both Wi-Fi and BLE have superior RF performance that is maintained even at high temperatures.

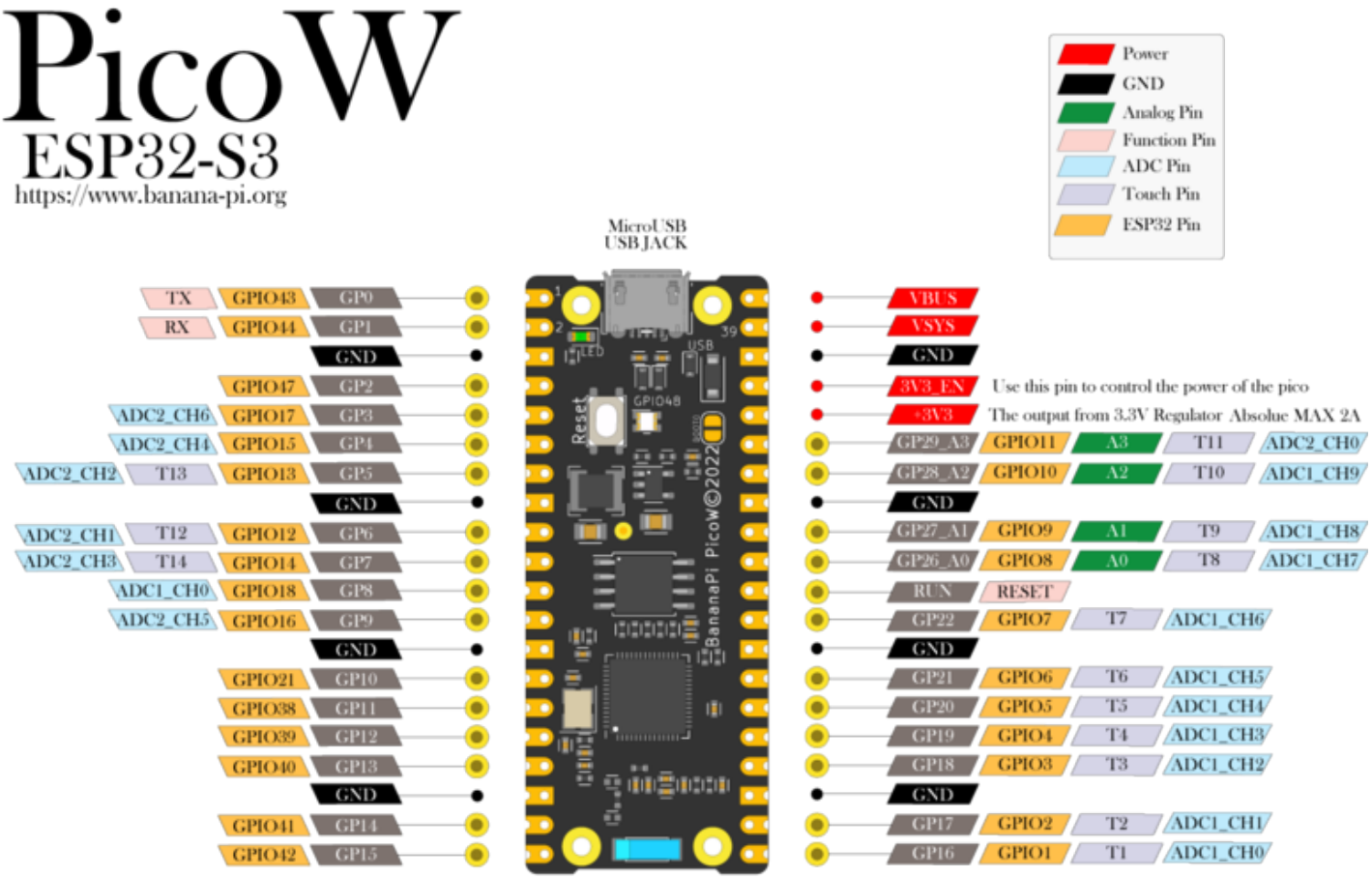
- AI Acceleration Support: ESP32-S3 has additional support for vector instructions in the MCU, which provides acceleration for neural network computing and signal processing workloads. The software libraries for the above-mentioned optimized functions will become available very soon, in the form of updates to ESP-DSP and ESP-NN.

- Rich IO interfaces: ESP32-S3 has 45 programmable GPIOs and common peripheral interfaces such as SPI, I2S, I2C, PWM, RMT, ADC, UART, SD/MMC host controller and TWAITM controller. Fourteen of the GPIOs can be configured as capacitive touch inputs for HMI interaction. In addition, ESP32-S3 is equipped with an ultra-low power coprocessor (ULP) and supports multiple low-power modes, making it widely applicable to various low-power application scenarios.
- Security mechanism: ESP32-S3 provides comprehensive security mechanism and protection measures for iot devices to prevent all kinds of malicious attacks and threats. It supports Flash encryption based on AES-XTS algorithm, secure startup based on RSA algorithm, digital signature and HMAC. Esp32-s3 also includes a new "World

Controller" module, which provides two non-interfering execution environments to implement a trusted execution environment or permission separation mechanism.

Hardware

Hardware interface

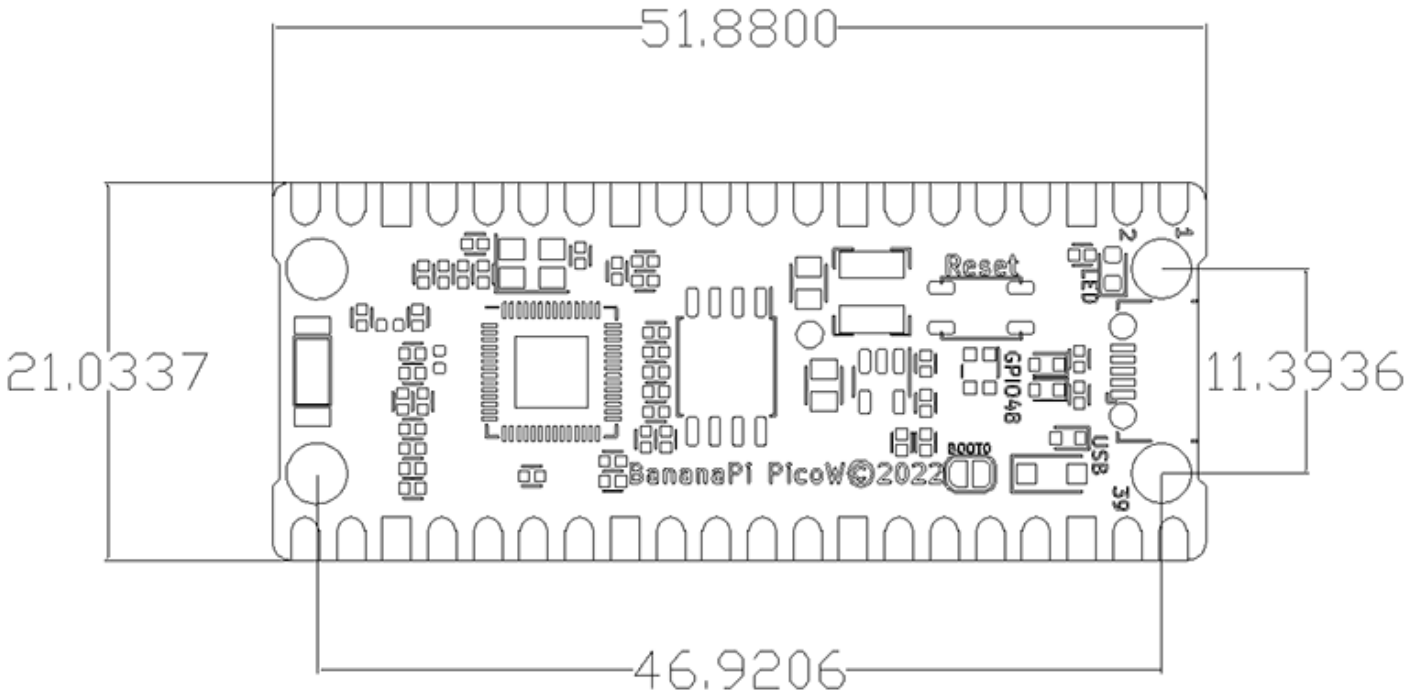


Hardware spec

BPI-PicoW-S3 Spec Sheet	
SoC	ESP32-S3, Xtensa® 32-bit LX7 dual core
Basic frequency	240MHz MAX
Operating temperature	-40℃~+85℃
On-chip ROM	384KB
On-chip SRAM	512KB
Extereal FLASH	8MB

In-packge PSRAM	2MB
WIFI	IEEE 802.11 b/g/n, 2.4Ghz band, 150Mbps
Bluetooth	Bluetooth 5, Bluetooth mesh
GPIO	BPI-PicoW-S3 has led out 27 available GPIOs
ADC	2 × 12-bit SAR ADC supporting 18 analog channel inputs
TOUCH Capacitive Touch Sensor	14
SPI	4
I2C	2. Support master or slave mode
I2S	2, input and output of serial stereo data
LCD	1, support 8-bit ~16-bit parallel RGB, I8080, MOTO6800 interface
CAMERA	1, supports 8-bit ~16-bit DVP image sensor interface
UART	3, supports asynchronous communication (RS232 and RS485) and IrDA
PWM	8 independent channels, 14-bit precision
MCPWM	2
USB	1 × Full Speed USB 2.0 OTG, MicroUSB Female
USB Serial/JTAG Controller	1, USB full speed standard, CDC-ACM, JTAG
Temperature sensor	1, the measurement range is –20 °C to 110 °C, for monitoring the internal temperature of the chip
SD/MMC	1 × SDIO host interface, with 2 card slots, supports SD card 3.0 and 3.01, SDIO 3.0, CE-ATA 1.1, MMC 4.41, eMMC 4.5 and 4.51
TWAI® Controller	1, compatible with ISO11898-1 (CAN specification 2.0)
Generic DMA Controller	5 receive channels and 5 transmit channels
RMT	4-channel transmit, 4-channel receive, shared 384 x 32-bit RAM
Pulse Counter	4 pulse count controllers (units), each unit has 2 independent channels
Timer	4 × 54-bit general-purpose timers, 16-bit clock prescaler, 1 × 52-bit system timer, 3 × watchdog timers
External crystal	40Mhz
RTC and Low Power Management	Power Management Unit (PMU) + Ultra Low Power Coprocessor (ULP)
Low power consumption current	10uA
Working Voltage	3.3V
Input voltage	3.3V~5.5V
Maximum discharge current	2A@3.3V DC/DC
Controllable full color LED	1
Controllable monochrome LED	1

Hardware Size



BPI-PicoW-S3 size chart	
Pin spacing	2.54mm
Hole Spacing	11.4mm/ 47mm
Hole size	Inner diameter 2.1mm/Outer diameter 3.4mm
Mainboard size	21 × 51.88(mm)/0.83 x 2.04(inches)
Thickness	1.2mm

The pin spacing is compatible with universal boards (hole boards, dot matrix boards) and breadboards, which is convenient

for debugging applications.

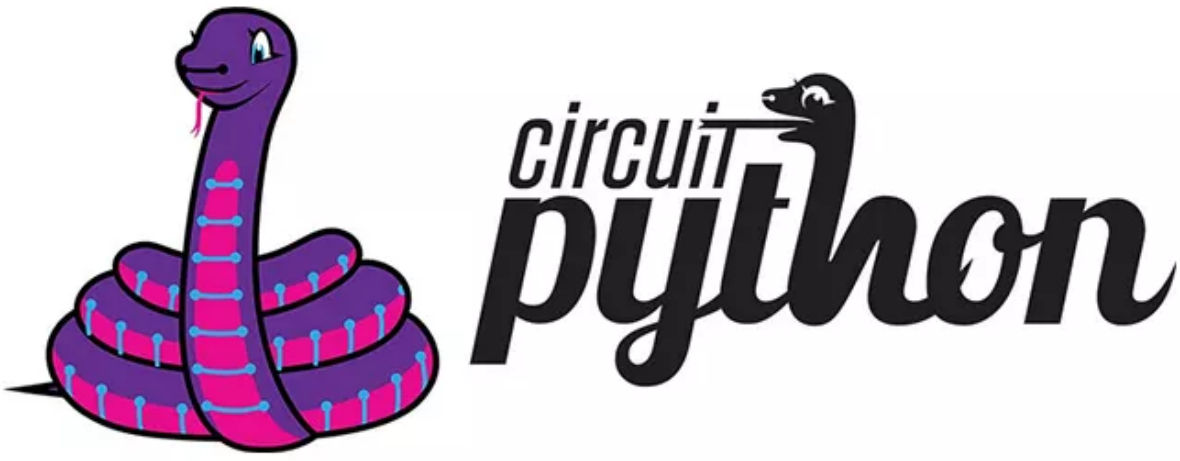
GPIO define

BPI-PicoW-S3 peripheral GPIO pin assignment		
Peripheral Interface	Signal	Pins
ADC	ADC1_CH0~9	GPIO 1~10
	ADC2_CH0~9	GPIO 11~20
Touch Sensor	TOUCH1~14	GPIO 1~14
JTAG	MTCK	GPIO 39
	MTDO	GPIO 40
	MTDI	GPIO 41
	MTMS	GPIO 42
UART	*Default assigned pins, can be redefined as any GPIO*	
	U0RXD_in	GPIO 44
	U0CTS_in	GPIO 16
	U0DSR_in	Any GPIO
	U0TXD_out	GPIO43
	U0RTS_out	GPIO 15
	U0DTR_out	Any GPIO
	U1RXD_in	GPIO 18
	U1CTS_in	GPIO 20
	U1DSR_in	Any GPIO
	U1TXD_out	GPIO 17
	U1RTS_out	GPIO 19
	U1DTR_out	Any GPIO
	U2	Any GPIO
I2C	Any GPIO	
PWM	Any GPIO	
I2S	Any GPIO	
LCD	Any GPIO	
CAMERA	Any GPIO	
RMT	Any GPIO	
SPI0/1	Used for FLASH and PSRAM	
SPI2/3	Any GPIO	
Pulse Counter	Any GPIO	
USB OTG	D-	GPIO 19 (internal PHY)
	D+	GPIO 20 (internal PHY)
	VP	GPIO 42 (External PHY)

	VM	GPIO 41 (External PHY)
	RCV	GPIO21 (External PHY)
	OEN	GPIO 40 (External PHY)
	VPO	GPIO 39 (External PHY)
	VMO	GPIO38 (External PHY)
	D-	GPIO 19 (internal PHY)
	D+	GPIO 20 (internal PHY)
USB Serial/JTAG	VP	GPIO 42 (External PHY)
	VM	GPIO 41 (External PHY)
	OEN	GPIO 40 (External PHY)
	VPO	GPIO 39 (External PHY)
	VMO	GPIO38 (External PHY)
SD/MMC	Any GPIO	
MCPWM	Any GPIO	
TWAI	Any GPIO	
Full Color LED	GPIO 48	
Monochrome LED	GPIO 46	

Software

CircuitPython



CircuitPython is an education-friendly open source derivative of MicroPython, supported and developed by Adafruit Industries.

In terms of ease of use, it goes a step further on the basis of MicroPython.

When the development board using CircuitPython firmware is connected to the PC, the PC will immediately get a USB storage disk.

And the python script file can be copied to this disk to allow the program to run on the development board.

This allows users to use it out of the box, because most modern personal operating systems and home PCs support USB storage disks.

Of course, in order to use REPL, at least a serial communication software needs to be installed, or a text editor that supports this function, such as Mu editor.

The CircuitPython community provides an extremely rich peripheral driver library, APIs documentation, and tutorials.

Even if there is no programming foundation, no hardware foundation, you can quickly get started from scratch.

CircuitPython does not support some microcontroller-specific libraries such as timer and hardware interrupt, nor does it support the multi-threaded _thread library. It only provides the asyncio library for writing concurrent code.

The code is very portable between microcontrollers supported by CircuitPython and single-board computers (SBCs) supported by Blinka. This is thanks to its efforts to unify APIs.

- Mu Editor Download Page
- Getting Started: Code CircuitPython with Mu Editor

Supported by the adafruit/circuitpython GitHub repository

https://github.com/adafruit/circuitpython/pull/7031

Supported by the adafruit/tinyuf2 GitHub repository

https://github.com/adafruit/tinyuf2/pull/250

Reference Resources :

- Adafruit: Welcome To CircuitPython
- Adafruit:CircuitPython Web Workflow Code Editor Quick Start
- Adafruit:CircuitPython Docs
- GitHub:CircuitPython-tricks
- BPI-Pico-S3 Getting Started, Code CircuitPython with Mu Editor

ESP-IDF

ESP-IDF is an IoT development framework officially launched by Espressif, supporting Windows, Linux and macOS operating systems.

It is recommended that developers install ESP-IDF via an integrated development environment (IDE):

- GitHub: ESP-IDF Eclipse Plugin Installation and Usage Guide
- ESP-IDF VSCode plugin | /master/docs/tutorial/toc.md GitHub: Installation and Usage Guide | bilibili: ESP-IDF VSCode Plugin Quick Operation Guide

Or select the corresponding manual installation process according to the operating system:

- Standard setup for Windows platform toolchain
- Standard setup for Linux and macOS platform toolchains

API:

- API Reference
- API Guide

In order to enable your BPI-Leaf-S3 development board to flash FLASH through USB-CDC, you need to set the development board to firmware download mode.

There are two methods of operation:

1. Connect to the computer via USB, press and hold the BOOT button, then press the RESET button and release it, and finally release the BOOT button.

2. Press and hold the BOOT button when the power supply is disconnected, then connect to the computer via USB, and finally release the BOOT button.

You need to confirm the interface in the device manager. The serial number of the interface in the firmware download mode and the normal mode may be different.

MicroPython

MicroPython is a lean and efficient implementation of the Python 3 programming language that includes a small subset of the Python standard library and is optimised to run on microcontrollers and in constrained environments.

Crowdfunded and open sourced in 2013 by Damien P. George.

The most obvious difference between it and the use of C programs to develop microcontrollers is that there is no need for lengthy compilation when verifying code.

Using serial communication software, enter commands through the REPL(read-eval-print-loop) to control the microcontroller, just like Python's REPL.

It is also possible to use some tools to upload a python script file to run inside the microcontroller.

Its implementation of Python3 includes the _thread library that supports multithreading and the asyncio library for writing concurrent code.

MicroPython aims to be as compatible with normal Python as possible to allow you to transfer code with ease from the desktop to a microcontroller or embedded system.

At the same time it also has some libraries specific for microcontrollers in order to take full advantage of the hardware features inside the microcontroller chip, such as timers, hardware interrupts, WiFi, etc., depending on the specific hardware.

While having the above features, it is compact enough to fit and run within just 256k of code space and 16k of RAM.

If you know Python you already know MicroPython.

On the other hand, the more you learn about MicroPython the better you become at Python.

Arduino

Arduino is an open source embedded hardware and software development platform for users to create interactive embedded projects.

The Arduino integrated development environment (IDE) is the software core of this platform, using the C/C++ programming language to develop projects.

The biggest feature of Arduino is to provide a unified API to develop all microcontrollers it supports, with very good code portability and reusability.

In addition, it simplifies the process of building a development environment, and all the development environments of microcontrollers it supports can be installed and configured with one click.

It also provides simple one-click mechanisms to compile and upload programs to a microcontroller.

Arduino IDE also integrates many routines, supplemented by a large number of comments, which can help users get started quickly.

A large number of excellent open source projects accumulated in the Arduino community are available for reference and learning, and there are quite a few driver libraries and APIs provided by chip manufacturers.

- Arduino IDE download address | Install and configure Arduino-ESP32 operating environment
- GitHub: BPI-Leaf-S3 Arduino Quick Start
- Arduino-ESP32 APIs

Resources

BPI-PicoW-S3 schematic : https://github.com/BPI-STEAM/BPI-PicoW-Doc/blob/main/sch/BPI-PicoW-V0.4.pdf